

## CLEISTOGAMY IN THE MALVACEAE

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## INTRODUCTION

Facultative cleistogamy is a phenomenon frequently overlooked. This was made clear by Biloni (1957) who grew *Pavonia sepium* St. Hil. under circumstances permitting daily observation of the plants for several years. He published a note on the flowers they produce (Biloni, 1945) without suspecting that, in addition to these showy chasmogamous flowers, they also produce abundant cleistogamous flowers. The observation of fruits maturing in the spring before flowering was apparent suggested the occurrence of cleistogamy, which he subsequently found does occur (Biloni, 1957).

If such intensive observation of living plants by a competent botanist fails immediately to disclose the occurrence of cleistogamy, botanists working primarily with dried plant materials may be expected to overlook it also. Consequently, only a few examples are to be found in the literature of cleistogamy in the Malvaceae. They are as follows:

SPECIES	TRIBE	AUTHORITY
<i>Pavonia hastata</i> Cav.	Ureneae	Heckel, 1879
<i>P. sepium</i> St. Hil.	Ureneae	Biloni, 1957
<i>Malva parviflora</i> L.	Malveae	Uphof, 1938
<i>Hibiscus trionum</i> L.	Hibisceae	Lassimonne, 1929

These few examples are distributed among three tribes, suggesting that facultative cleistogamy is of widespread occurrence in the family.

## OBSERVATIONS

A number of species of the Malvaceae, all in the tribe Hibisceae, have been under cultivation and regular observation for several years. Five species have shown some tendency to produce cleistogamous flowers under the environmental conditions in which they have been grown. Comparative observations have shown that several other closely related species do not produce cleistogamous flowers. The five species are discussed individually as follows.

*Hibiscus denudatus* Benth. was grown from seed collected in the Cape Region of Baja California by I. L. Wiggins. Under greenhouse conditions that appeared adverse to the optimum growth of this species, it produced both cleistogamous and chasmogamous flowers, the former in greater abundance.

[Note added after manuscript had gone to press.]

A recent paper by Brown (Brown, Meta S. Anomalous flowering *Gossypium australe* F. Muell. Jour. Hered. 53:139-141, 1962.) refers to the same phenomenon noted here and illustrates a cleistogamous flower at anthesis, dissected to show the reduction of parts.

*Cienfuegosia argentina* Gürke var. *hasslerana* (Hochr.) Hassler f. *β escholtzioides* Hassler was grown from seed collected in Argentina by Manuel Gutierrez. Under greenhouse conditions that appear to be favorable to its growth, this species produces chasmogamous flowers only rarely, while literally hundreds of fruits result from cleistogamous flowers (fig. 1, *c* and *d*). Chasmogamous flowering occurs in the open. Dissection of cleistogamous buds shows a marked reduction of flower parts with, for example, only five or six anthers.

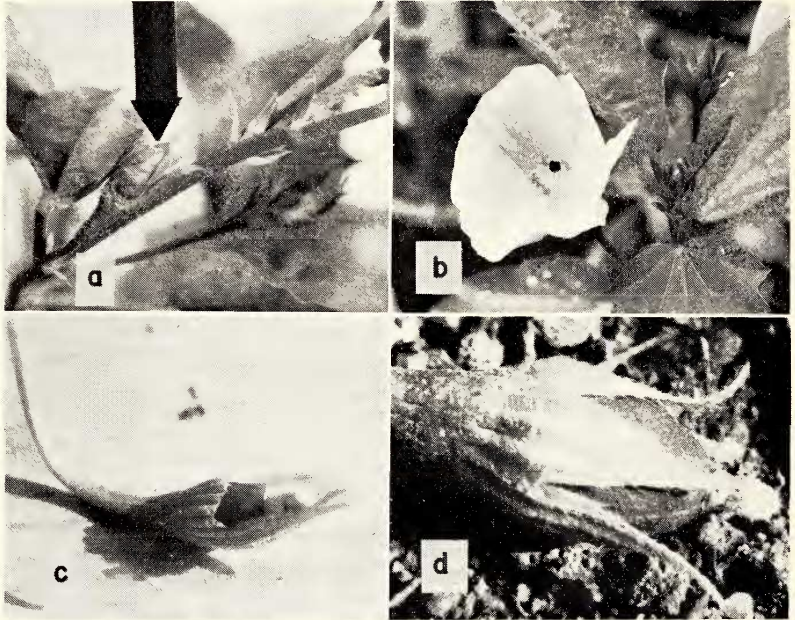


FIG. 1. Flowers and fruits of *Cienfuegosia*: *a-b*, *C. drummondii* (A. Gray) Lewton: *a*, young fruit developing from cleistogamic flower with persisting "cap" (two bracts and one calyx lobe removed),  $\times 1$ ; *b*, chasmogamous flower,  $\times \frac{3}{4}$ . *c-d*, *C. argentina* Gürke var. *hasslerana* (Hochr.) Hassler: *c*, young fruit developing from cleistogamic flower with persisting "cap" (two calyx lobes removed),  $\times 3$ ; *d*, nearly mature fruit developing from cleistogamic flower with persisting "cap,"  $\times 3\frac{1}{2}$ .

*Cienfuegosia drummondii* (A. Gray) Lewton was grown from several seed accessions from southern Texas obtained through C. F. Lewis and M. Lukefahr. In the greenhouse and in the open it produces both chasmogamous (fig. 1, *b*) and cleistogamous flowers (fig. 1, *a*) in approximately equal proportions. The fruits developing from the two types of flowers cannot be distinguished in size or number of seeds.

*Gossypium australe* F. von Muell. was grown from seed obtained from J. H. Saunders, Khartoum, though the native habitat of this species is north-central to north-west Australia. Under conditions apparently

favorable to its growth and reproductive activity, it has set numerous fruit, but its first chasmogamous flower was produced only after some twenty fruits had set from cleistogamous flowers. Later flowering is of both types. Chasmogamous flowers tend to develop at the first node of a fruiting branch with cleistogamous flowers developing at subsequent nodes.

The fruits developing from the two types of flowers of *G. australe* can be distinguished by the size of the calyx. The calyx lobes of the cleistogamic fruit exceed the bracteoles by only 2–3 mm. (fig. 2, *a*), while in the chasmogamic flower and fruit the calyx lobes exceed the bracteoles by 9–10 mm. (fig. 2, *b*). In either case the bracteoles are of essentially equal size.

*Gossypium bickii* Prokhanov [*Notoxylinon pedatum* (Bailey) Lewton] was grown from seed collected in central Australia by George Chippendale. This species is closely allied to *G. australe* (Fryxell, in manuscript) and shares with it the propensity for producing cleistogamic flowers. Indeed, a cleistogamic "cap" has been observed on the syntype of *G. bickii* (*E. W. Bick* 82, Sept.-Oct., 1910, BRI).

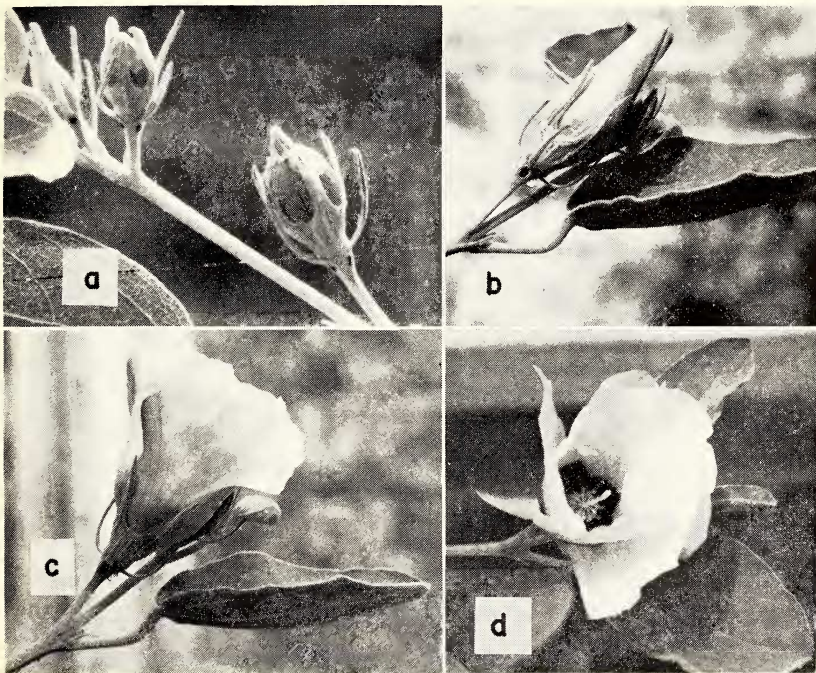


FIG. 2. Flowers and fruits of *Gossypium australe* F. Muell.: *a*, fruits developing from cleistogamic flowers at various stages of development with "cap" persisting,  $\times 1\frac{1}{2}$ ; *b*, chasmogamic flower bud on day of anthesis,  $\times 1$ ; *c-d*, the same flower as in *b*, a few hours later,  $\times \frac{3}{4}$ .

Should the "cap" (the dried corolla of the cleistogamic flower) persist through the development of the fruit, its presence is, of course, diagnostic for cleistogamy for that fruit for all the species discussed. In all cases, also, the first flowers produced are cleistogamic; chasmogamous flowers are produced after the plant has attained additional growth.

#### DISCUSSION

Facultatively cleistogamous plants are known to depend upon environmental conditions for the degree to which their cleistogamy is expressed (Brown, 1952; Ernst-Schwarzenbach, 1956; Harlan, 1945; Uphof, 1938). Therefore, one cannot state with any assurance that a given species produces cleistogamous flowers in any particular proportion except with reference to some specific set of environmental conditions. Of the five species under discussion here, none was growing in its native habitat.

I do not wish to imply that differences in frequency of cleistogamy are not real, because they doubtless are. But without controlled experiments in which environmental variables are carefully manipulated (as was done, for example, by Brown), discussions of the frequency of cleistogamy are not productive. Nevertheless, comparisons with related taxa in which cleistogamy is absent can be of value.

In addition to the two species of *Cienfuegosia* described herein as cleistogamic, two others have been observed sufficiently to state that they do *not* produce cleistogamic flowers under the various conditions in which they have been grown. They are *C. heterophylla* (Vent.) Garcke and *C. hildebrandtii* Garcke.

Similarly, in *Gossypium*, extensive observation of many species of this genus has heretofore failed to bring to light examples of cleistogamy.<sup>2</sup> This genus, of course, has been intensively studied by botanists for many years. However, *G. australe* and *G. bickii*, the species described here as facultatively cleistogamic, have become available in culture only recently. *Gossypium australe* originally was placed in *Gossypium* by von Mueller in 1858. Subsequently it was assigned by various authors to *Fugosia*, *Cienfuegosia*, *Hibiscus*, and *Notoxylinon* (Lewton, 1915). More recently it was returned to *Gossypium* on morphological grounds by Prokhanov (1947) and for cytological reasons by Saunders (1961). *Gossypium bickii* was first described as *Fugosia pedata* by Bailey in 1910. It was included in *Notoxylinon* by Lewton (1915) and more recently transferred to *Gossypium* by Prokhanov (1947). The inclusion of these two species in *Gossypium* is considered sound by the present author, although the occurrence in them of cleistogamy is unusual for *Gossypium* and must be given attention in classifying and understanding the genus (Fryxell, in manuscript). In both *G. australe* and *G. bickii* from their native habitat the

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<sup>2</sup> A mutant strain of *G. barbadense* L. is extant that is described as "cleistogamic" but it does not have cryptic floral development with a marked reduction of floral parts. The mutant strain merely has a normal chasmogamous flower that fails to open fully.

author has observed cleistogamic "caps" on herbarium specimens, indicating that cleistogamy is not confined to artificial growing conditions.

I can say little concerning the taxonomic value of cleistogamy as an aid to understanding the large and complex genus *Hibiscus*, because of my limited knowledge of that genus. However, the examples described of differential incidence of cleistogamy below the level of genus in the genera *Cienfuegosia* and *Gossypium* point to this phenomenon as an additional means of understanding the subgroups of these genera.

#### SUMMARY

The incidence of cleistogamy in the Malvaceae is reviewed, and the occurrence of cleistogamy is noted in the following species of the Hibiscaceae: *Hibiscus denudatus* Benth., *Cienfuegosia argentina* Gürke var. *hasslerana* (Hochr.) Hassler, *C. drummondii* (A. Gray) Lewton, *Gossypium australe* F. von Muell., and *G. bickii* Prokhanov.

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